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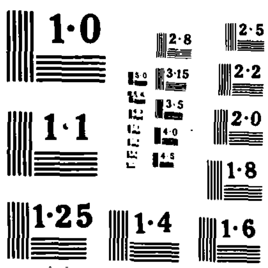
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DEPARTMENT OF THE ARMY
ASSISTANT SECRETARY OF THE ARMY
RESEARCH, DEVELOPMENT AND ACQUISITION
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ARMY SCIENCE BOARD

FINAL REPORT OF THE AD HOC SUBGROUP

ON

NONDEVELOPMENTAL C3I ITEMS

1984/1985

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This report addresses the findings and recommendations of the Army Science Board Ad Hoc Subgroup on Nondevelopmental C^3I Items. The study provides a risk classification cube which allows users to identify where potential NDI efforts will fall. Other recommendations included in the report identify the criticality of market surveys, revising NDI in the current acquisition process, testing, logistics issues, software issues and impediments to NDI acquisitions.

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Item 7. (continued)

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FOREWORD

The Army Science Board (ASB) is pleased to submit this final report for the 1984/85 Ad Hoc Subgroup on Nondevelopmental C^3I Items to the Department of the Army, Office of Assistant Secretary. The Board accomplished the study by forming an ad hoc subgroup panel consisting of ASB members knowledgeable in C^3I principles and the functional applications which could best be satisfied by the use of nondevelopmental items. The panel, chaired by Dr. Leon Riebman, was augmented by selected board members and personnel who effectively represented industry, academia and government.

The panel identified and analyzed the key problem areas in the Army's use of NDI throughout the applicable equipment spectrum. Based on its review of the problem areas, the Army Science Board Ad Hoc Panel has proposed a number of recommendations. These are discussed in the report.

NDI Army Science Board

ARMY SCIENCE BOARD
AD HOC SUBGROUP

Nondevelopmental C^3I Items

Contents

	Page
Section I - Introduction	
1. Purpose	1-1
2. Definition	1-3
3. Terms of Reference	1-5
4. Panel Organization	1-7
5. Summary of Plenary Meetings	1-8
Section II - NDI Risk Classification Cube	
1. Generic	2-1
2. Classification Scheme	2-2
a. Development Source	2-2
b. Required Modification	2-5
c. First Unit Equipped	2-6
3. Level of Perceived Risk	2-12
Section III - Focus of Review	
1. Basis	3-0
2. Areas	3-1
Section IV - Findings	
1. Generic	4-0
2. Availability of Technology	4-2
3. Revision of NDI Acquisition Process	4-8
4. NDI Testing Procedures	4-12
5. Review of TRI-TAC as Role Model	4-15
6. Life Cycle Support	4-16

	Page
Section IV - Findings (continued)	
7 Impediments to NDI Initiatives	4-18
8. Foreign Technology Items	4-20
9. Software Issues	4-22
Section V - Recommendations	
1. Generic	5-0
2. Market Surveys	5-3
3. NDI Testing	5-4
4. Logistics Issues	5-6
5. Software	5-8
6. Revised Acquisition Process	5-10
a. Requirements Generation Phase	5-10
b. Qualification Phase	5-13
c. Bidding Phase	5-13
Appendix A - Terms of Reference	
Appendix B - Glossary	
Appendix C - Distribution List	

Section I

Introduction

	Page
Purpose	1-1
Definition	1-3
Terms of Reference	1-5
Panel Organization	1-7
Summary of Plenary Meetings	1-8

PURPOSE

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To review the use of NDI in C^3I system acquisition procedures in order to field equipment at an earlier date and save money by making use of NDI, with acceptable trade-offs.

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DEFINITION

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NDI pertains to acquistions used to satisfy new equipment or software requirements while not being started from future government research and development funds.

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TERMS OF REFERENCE

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The panel was to address:

1. *The technology available for converting NDI for military applications.*
2. *Revision in the Army acquisition process (where needed) to facilitate NDI procurement.*
3. *Use of Army test requirements and procedures to assure that appropriate testing of NDI is accomplished.*
4. *Recent revisions to the TRI-TAC architecture as an example of steps being taken to encourage NDI.*
5. *Logistics to support NDI.*
6. *Problems that impede this initiative.*

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PANEL ORGANIZATION

NDI Army Science Board

Chairman	*Dr. Leon Riebman*	*AEL Industries, Inc.*
Members	*Mr. Robert L. McDaniel*	*Science & Technology Associates, Inc.*
	Mr. John R. Moore	*Northrop Corporation*
	Dr. L. Warren Morrison	*BDM Corporation*
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	Dr. Robert C. Williges	*Virginia Polytechnic Institute & State University*
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Department of the Army Staff Assistant	*LTC Frank J. Sisti*	*Headquarters, Department of the Army*
Cognizant Deputy	*Dr. Mark R. Epstein*	*Office of the Assistant Secretary of the Army*

SUMMARY OF PLENARY MEETINGS

NDI Army Science Board

DATE	LOCATION	PURPOSE
26 March 1984	Pentagon	Panel Chairmen meeting with original study sponsors; M. G. Rockwell and B. G. Lee
26-27 April 1984	Pentagon	Indoctrination, receive guidance and NDI background; presentations by DARCOM, PM TACMIS, PM OPTADS and PM ATACS
11-12 June 1984	Pentagon	Congressional perspective; presentations by 9th ID ADEA, TRADOC, AIRMICS, ODCSRDA, PM SPADS and OASA IL&FM
19-20 July 1984	Ft. Monmouth, NJ	Presentations by CECOM - FMILS, Small Business Office, PA&T, PM OPTADS, PM SATCOM, PM TMDE, ERADCOM, AVRADA and CSA
25-26 September 1984	Rosslyn, VA	Presentation by Dr. Trainor; panel working session

SUMMARY OF PLENARY MEETINGS

NDI Army Science Board

16-17 October 1984	*McLean, VA*	*Panel working session*
4-5 December 1984	*Rosslyn, VA*	*Panel working session*
31 January - 1 February 1985	*Rosslyn, VA*	*Panel working session*
18-19 March 1985	*Rosslyn, VA*	*Panel working session*
26-27 March 1985	*Ft. Leavenworth, KS*	*Peer review of panel efforts (ASB, C^3I Functional Subgroup)*
25-26 April 1985	*Rosslyn, VA*	*Final panel working session*

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Section II

NDI Risk Classification

	Page
1. Generic	2-1
2. Classification Scheme	2-2
a. Development Source	2-2
b. Required Modification	2-5
c. First Unit Equipped	2-6
3. Level of Perceived Risk	2-12

II

NDI RISK CLASSIFICATION

1. Generic

Early in the deliberations on NDI issues it became obvious that a classification scheme was necessary to capture the complexity of various NDI alternatives. In order to develop this classification scheme, several background sources and classification dimensions were considered. The source documents most useful to our discussion were:

CECOM Nondevelopment Item (NDI) Acquisition Guide, U.S. Army Communications-Electronics Command, Final Draft, June 1984.

Trainor, R.J., The processing requirements documents study, ASB draft report, September 1984.

Several dimensions were considered for the NDI classification scheme. Some of the major candidates were:

DEVELOPMENTAL SOURCE -- the basis on which the item was originally developed.

REQUIRED MODIFICATION -- the extent to which modifications are needed in order to make the NDI acceptable to the Army.

FIRST UNIT EQUIPPED (FUE) -- the number of months required to field the first NDI item.

COMPLEXITY -- the intricacy of the NDI components.

TYPE OF NDI -- the degree to which the NDI is a replacement, new capability, or major system item.

COST -- the cost of a NDI unit or the total anticipated procurement cost.

Although each of these dimensions represents an important consideration in NDI procurements, some of them are highly interrelated, are difficult to quantify, and are difficult to determine distinct cut-off levels. The consensus is that three of these dimensions seem to capture most of the considerations made in NDI procurements. These dimensions are DEVELOPMENTAL SOURCE, REQUIRED MODIFICATION, and FUE.

Section II - NDI Risk Classification

2. Classification Scheme

The NDI classification scheme is depicted as three orthogonal dimensions in Figure 1. Each of these dimensions consists of several levels of NDI consideration.

a. Developmental Source. Four sources of NDI are considered in this classification. In each case, the major development of the item was completed in that source, and the resulting item is applicable to Army requirements. These four sources include:

1. COMMERCIAL ITEMS -- This level includes all items developed in the commercial market that are appropriate for Army use (e.g., power supplies, test equipment, telephone systems, etc.).

2. OTHER SERVICES AND ARMY INVENTORY -- Items that were already developed for use in other U.S. military systems and are appropriate for use in the system under consideration are included in this level (e.g., software used in Navy, Air Force, or other Army systems).

3. FOREIGN MILITARY -- This level is similar to the previous level if the source of development is a military ally (e.g., German military radar). This is listed as a separate level, because more modifications of these NDIs may be required than those from other U.S. military systems.

4. INDUSTRIAL RISK DEVELOPMENT (MILITARY EQUIPMENT) -- These items include NDIs in which the major development was conducted by industry for potential military application (e.g., items developed through IRAD programs).

NDI RISK ASSESSMENT

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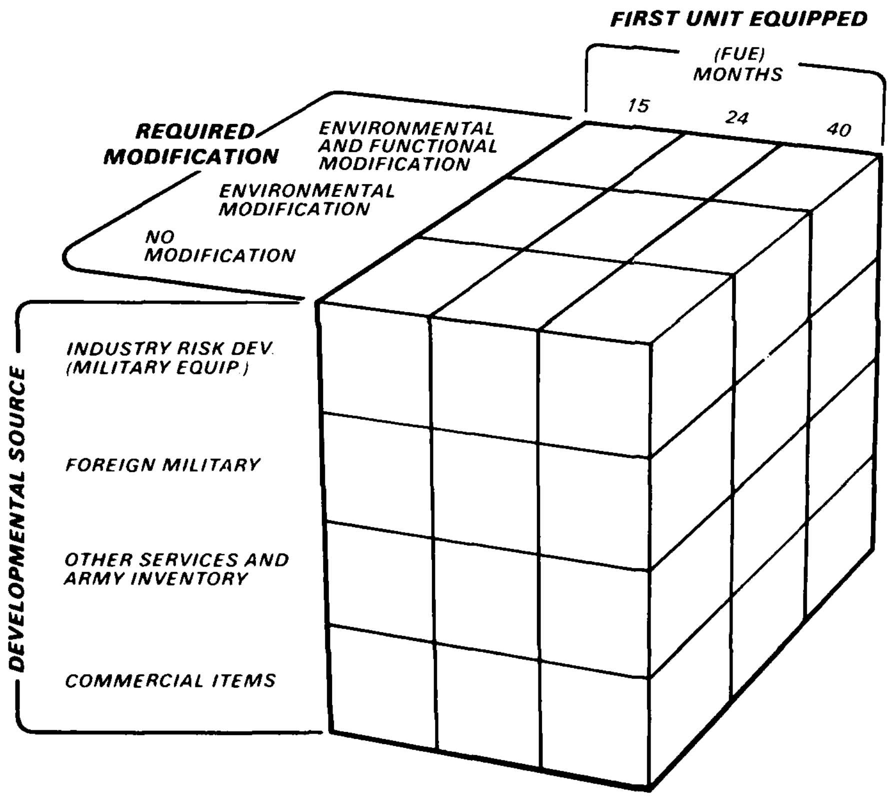

FIGURE 1.

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Section II - NDI Risk Classification

b. Required Modification. The second dimension of the NDI classification scheme shown in Figure 1 deals with the amount of modification of the NDI in order for it to be acceptable for Army use. Three levels of modification are included in this classification scheme.

1. NO MODIFICATIONS -- All NDIs that require either no modification at all or only slight modification such as color change. Items in this category will not require any environmental or functional modifications.

2. ENVIRONMENTAL MODIFICATION -- Items that require modifications to meet Army environmental operational conditions are in this category. For hardware items, environmental modifications include those required by MILSPECS. For software items, environmental modifications are those required by the Army operating system using that software item.

3. ENVIRONMENTAL AND FUNCTIONAL MODIFICATION -- This level of modification includes all NDIs that must be modified both in terms of environmental and functional constraints.

c. First Unit Equipped. The final dimension of the classification scheme shown in Figure 1 is the amount of time anticipated for the first unit to be equipped with the NDI. This dimension is analogous to the three types of NDIs discussed in the CECOM Nondevelopmental Item (NDI) Acquisition Guide (June 1984). The approach, however, is to specify the three levels in terms of anticipated FUE dates instead of defining the type of nondevelopmental item since the types of items are defined in terms of the other two dimensions of the classification scheme. The three levels of FUE in the CECOM guide include:

1. 15 MONTHS -- All NDIs in which the FUE is expected within fifteen months are included in this category. The NDI acquisition process as specified in the CECOM guidelines for this level is depicted in Figure 2.

2. 24 MONTHS -- All NDIs requiring more than 15 but less than 24 months are included in this level. The flow diagram for the acquisition process for this FUE level according to the CECOM guidelines is shown in Figure 3.

3. 40 MONTHS -- All NDIs requiring between 24 and 40 months are included in this third level. The CECOM recommended acquisition process for this level of FUE is shown in Figure 4.

CECOM RECOMMENDED NDI ACQUISITION PROCESS FOR 15 MONTH FUE.

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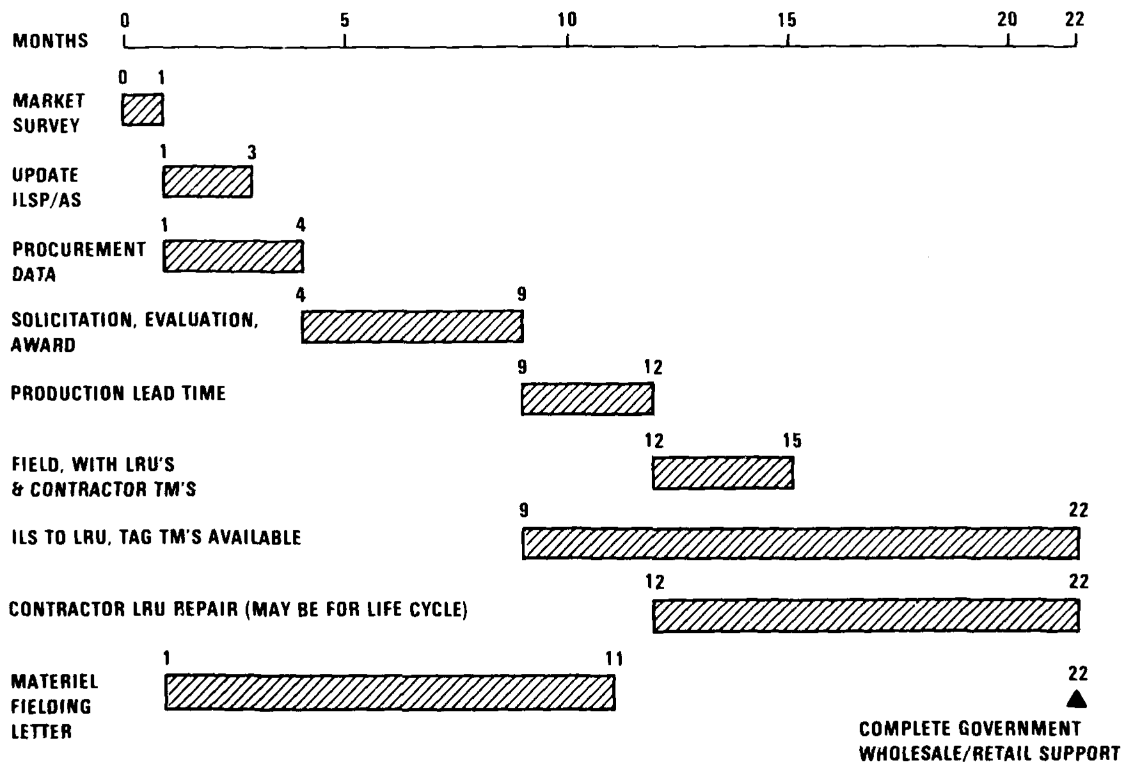

FIGURE 2.

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CECOM RECOMMENDED NDI ACQUISITION PROCESS FOR 24 MONTH FUE.

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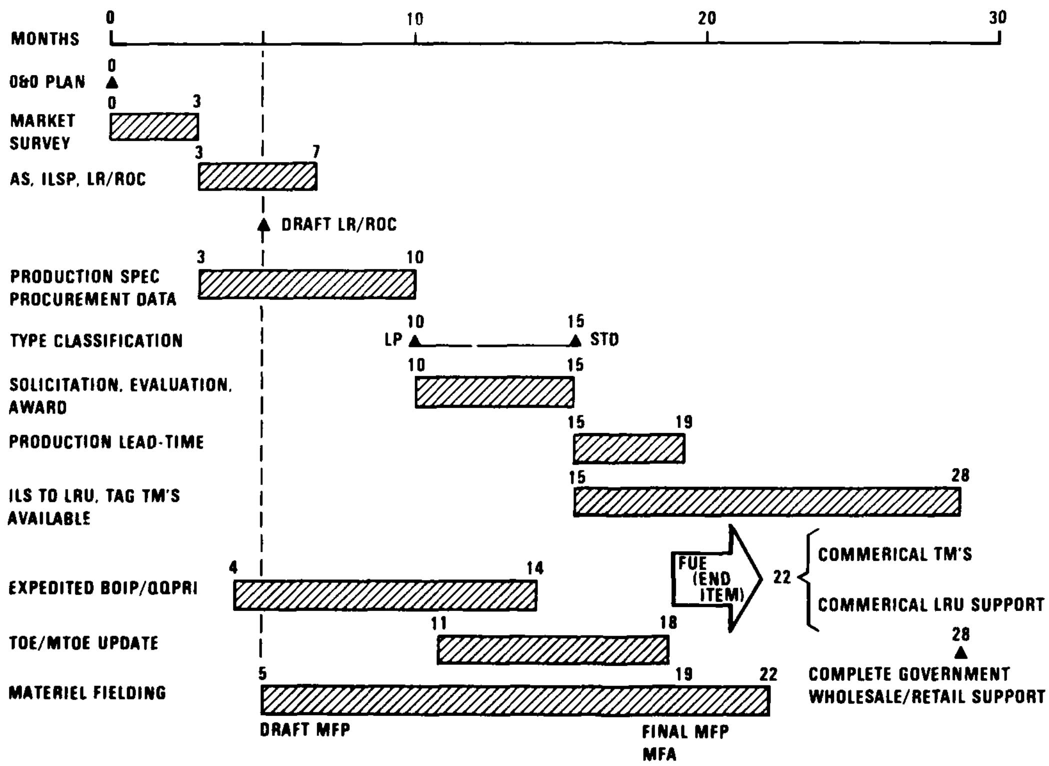

FIGURE 3.

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CECOM RECOMMENDED NDI ACQUISITION PROCESS FOR 40 MONTH FUE.

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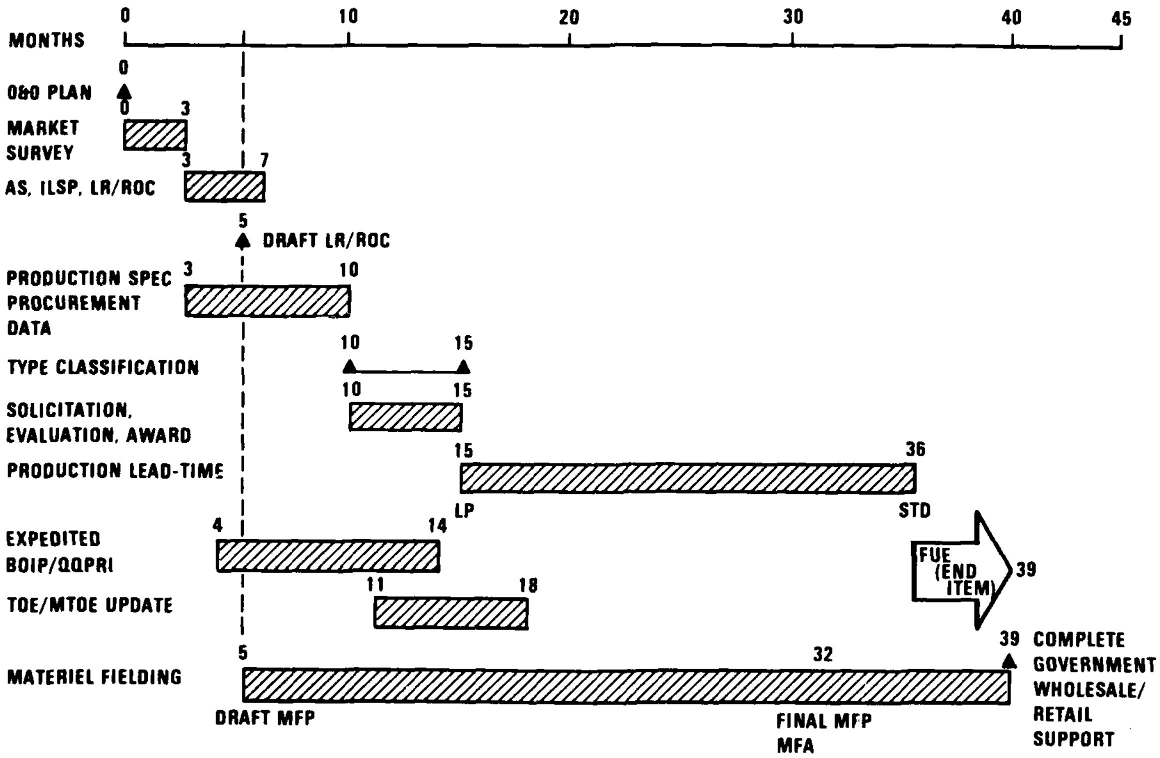

FIGURE 4.

Section II - NDI Risk Classification

3. Level of Perceived Risk

The NDI classification scheme shown in Figure 1 can be used to determine the level of risk of a NDI approach. Each of the dimensions is stated in terms of increasing levels of risk to NDI. By combining these dimensions, an overall risk level can be determined.

As shown in Figure 5, the lowest NDI risk exists with commercial items requiring no modification with a FUE of no more than 15 months. Likewise, the highest NDI risk occurs with industrial development that requires both environmental and functional modification resulting in a FUE of approximately 40 months. The diagonal from the lowest risk to highest risk cell in the classification cube approximates an increasing level of NDI risk. The exact level of risk in each of the resulting cells of the classification scheme needs to be determined and will be a function of the relative weighting of each dimension to overall risk. In addition, consideration needs to be given to possibly determining a threshold level of risk the Army is willing to accept in NDI. Previous NDI programs can be classified by this scheme and used as examples to help determine weightings of the various dimensions and possible thresholds for NDI risk.

NDI RISK CLASSIFICATION

NDI Army Science Board

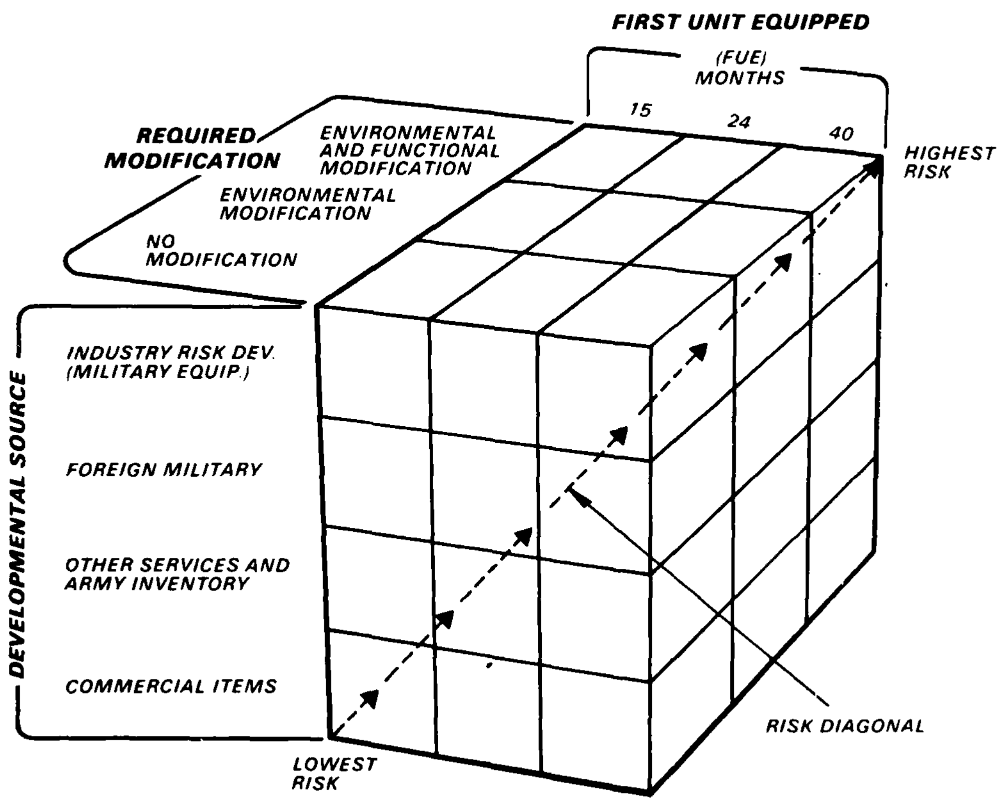

FIGURE 5.

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Section III

Focus of Review

	Page
1. Basis	3-0
2. Areas	3-1

III

FOCUS OF REVIEW

The panel used the terms of reference as the baseline for identifying the direction of their work. In conjunction with this baseline, the panel solicited and received background information and guidance from a number of the principals of the Department of the Army. With this background the panel structured their work. This identification process led to NDI topics which would be the focus of review.

The first efforts of the panel were based on reviewing the fundamentals of what is known as non-developmental items and their acquisition processes. The very first discovery was that there was a wide variation concerning the definition of the term and, because of this diversity, no coherent process was discernible. During this formative period, the panel was beginning to discuss a scheme for defining NDI with all of its ramifications. Later on, an NDI classification scheme was solidified by the panel and the report expands on this work (Section II). Originally, six variables were addressed, but later it was decided that three variables were more appropriate and that is the form in which the final scheme is explained. This scheme was entitled the NDI Risk Classification Cube.

Importantly, the criteria of the scheme are "necessary but not sufficient" for the definition to be applied to various candidates. The result was that if a particular candidate did not meet the criteria of the scheme it should not be classified as an NDI candidate. If the candidate does meet those criteria, it is only a candidate for NDI and requires further investigation in order to qualify for an NDI recommendation. This approach provides a screening methodology which assists in narrowing the available choices.

FOCUS OF REVIEW

NDI Army Science Board

The following areas were identified as the panel's focus of review:

- *Risk Classification Cube*
- *Impediments to NDI Acquisition*
- *Software Issues*
- *Foreign Military Equipment*
- *Integrated Logistics Support*
- *Testing Procedures*
- *Acquisition Considerations*

Section III - Focus of Review

The panel then received presentations from a series of individuals who have been involved in NDI acquisition or were in the process of such an acquisition. These hearings, coupled with extensive reading and individual panel member research, led to a series of findings which were felt to be salient issues within the larger question of the NDI process and, when addressed, led to the recommendations for "program success".

The report illuminates and expands on those findings and recommendations which the panel determined to be most important to the overall process of NDI.

Section IV
Findings

		Page
1.	Generic	4-0
2.	Availability of Technology	4-2
3.	Revision of NDI Acquisition Process	4-8
4.	NDI Testing Procedures	4-12
5.	Review of TRI-TAC as Role Model	4-15
6.	Life Cycle Support	4-16
7.	Impediments to NDI Initiatives	4-18
8.	Foreign Technology Items	4-20
9.	Software Issues	4-22

IV

FINDINGS

1. Generic

The concept of NDI is complex and often misunderstood. Due to the variety of potential NDI items, which might range from a component in a C^3I system to a complete system itself, recommendations concerning NDI must be considered in terms of a variety of potential NDIs available to the Army. Consequently, a classification scheme is necessary to categorize NDI alternatives in terms of potential risk to the Army in choosing an NDI procurement approach.

Generic Findings

The NDI concept is widely misunderstood.

2. Availability of Technology

Most of the functions that must be performed by military C^3I systems and equipments have commercial counterparts in the fields of information acquisition, processing, communication, fusion, analysis, storage, utilization and human interfaces. The commercial implementation of these functions includes various aspects of high-technology electronics and computer science. Furthermore, it is reasonable to expect that commercial markets for communications, business systems, information handling, office equipment and expert systems will continue to stimulate technological advances in components, systems architecture, human interfaces and software, including applications of various forms of artificial intelligence (AI). This suggests that much of the technology needed for military C^3I functions will continue to be available in commercially-produced items. In addition, C^3I systems and equipments are continually being developed by the Navy, Air Force and foreign military sources to handle the more sophisticated C^3I requirements discussed in the following paragraphs.

The above statements would seem to indicate that many of the Army's C^3I requirements can now be, and will continue to be, supplied by NDI. Whereas this is certainly true for certain classes of C^3I functions which do not require low probability of intercept (LPI), anti-jam (AJ), and/or radiation (electromagnetic pulse) hardness, the Army must avoid planning to secure so much of its C^3I equipment without paying for its development that it dries up the industrial and technological base for strictly military C^3I. This can be appreciated when it considered that Army C^3I requirements will increasingly involve LPI, AJ, automatic pattern recognition (for cueing and rapid situation analysis), extreme amounts of information rate compression and the ability to survive and function in the presence of various types of radiation, EMP and chemicals. All of these characteristics are of little or no use for commercial applications. Furthermore, much of the state-of-the-art microelectronic technology can only be justified by military requirements for integrated circuits and sensors, since the large nonrecurring costs and long design-in times endemic to military programs preclude their being made part of viable business plans for commercial applications.

Availability of Technology

- *The required technology is available from multiple sources within the "worldwide community."*
- *Complete dependence on off-the-shelf C^3I items would degrade the national technical base and would not be acceptable national policy.*
- *Current methods (procedures) of conducting market surveys for NDI availability/interest are not comprehensive.*

Section IV - Findings

In selecting candidates for C^3I NDI, it is important to separate those that require LPI, AJ and/or radiation/EMP hardness from all others. Those items with such uniquely military requirements can only qualify for NDI if they can make use of suitable developments by other Army, Navy, Air Force or foreign military programs. Accordingly, any attempt to identify such NDI will require a continuing knowledge of the programs that have been, are being, or are planned to be developed by such sources. Where NDI is to involve a major system or piece of equipment, such information is generally known by the Army material managers.

However, important NDI can be applied at lower levels of system integration such as antennas, power supplies, displays, processors, electronic components and software programs. Here it is very much less likely that material managers will be aware of valid NDI candidates. This results not only from the fact that many such items were developed for other than C^3I systems, but also from the fact that such lower-tier elements are usually selected by the contractors for higher level of integration items. Frequently such contractors are not aware of the existence of other such NDI candidate developments because of security and proprietary restrictions on the dissemination of information necessary to identify them. Indeed, the only way that such information can frequently be brought to the attention of higher level of integration contractors is at the initiation of the marketing organizations of the lower level contractors who know enough about the system needs to recognize the opportunity for business.

For the class of C^3I requirements that can be met by commercial products or software, it is important to recognize the opportunities for NDI at all levels of integration. However, in identifying candidate sources for NDI, care must be exercised not to use cost, schedule and performance criteria alone (as is frequently done by material managers in both the Army and higher integration level contractors).

This is particularly true for C^3I items because so many of them depend upon advanced, rapidly obsolescent electronic technology and are, therefore, developed to satisfy pent-up market desire. Since such demand market businesses are characterized by rapid growth, saturation, excess capacity, price wars and "shakeouts" (which result in some suppliers going bankrupt and others discontinuing manufacture of the saturated market items), an important criterion for NDI source qualification must be the probable survivability of the candidate source as a supplier in order to assure future resupply. Examples of such commercial items which have reached saturation include hand-held calculators, digital watches, citizen band radios, video games, personal computers, various types of office equipment, memory discs, 16K and 64K random access memories (RAM) and 16-bit microcomputers.

Because of the differences in objectives between commercial and military equipment businesses, and because some commercial suppliers may not continue to produce selected NDI items, it is also important, in any market survey conducted to find potential NDI candidates, to consider the present and probable future ability of each NDI candidate supplier to provide product support throughout the course of the program.

It is presently difficult to estimate the extent to which market surveys for NDI suppliers adequately consider either the probable capability of a source as a future resupplier or to provide adequate present and future support.

Market surveys to ascertain NDI availability and suitability must be substantially more comprehensive than they appear to be at present. This means that they must be fair to the point of avoiding any possible bias by a contractor authorized to arrive at a make-or-buy decision. Accordingly, such surveys should be made by a material manager who has no vested interest in a "make" decison.

Section IV - Findings

Market surveys should use elimination procedures that do not rely solely on sales literature or written proposals. Such items will frequently be the first step in arriving at a "broad list" of NDI supplier candidates. However, any final "short list" of NDI supplier candidates should also include: a) independent performance and reliability tests of candidate items; b) capability surveys to determine the suppliers' existing capabilities for both production and product support; c) determination of the probability that the suppliers of the items for which there is a commercial demand market will survive the inevitable shakeout, or that their items are replaceable by items from other suppliers; and d) the interest of the candidate suppliers in dealing with the Army.

In market surveys conducted to determine the availability and desirability of NDI equipment, from either commercial or defense businesses, it is important to recognize that NDI can be desirable at all levels of integration, including subsystems and components. However, the use of NDI at lower levels of integration inevitably involves market surveys by the integrating contractors (although approval of the selection and any necessary realization of specifications must ultimately rest with the Army material manager). Frequently, the knowledge of the availability of potential NDI needs at lower levels of integration must rely upon dissemination of information to the population of potential suppliers and upon the initiative of the marketing organizations of potential suppliers to relate their products or software programs to vaguely understood needs. On some programs, an impediment to such an approach is the security classification of program element information.

A particularly difficult situation occurs when the best (or only) NDI candidates exist in other classified (particularly special access required) programs. It is not clear what, if any, formalized approaches to market surveys are appropriate in those cases.

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3. Revision of NDI Acquisition Process

The acquisition organizational structure on both the combat developments side and the materiel acquisition side have strong intellectual motivations that are counterproductive to the concept of NDI. On the combat developments side, requirements are generally defined by young officers who want the best equipment for operating forces and do not feel the pressures of budget allocation procedures. These officers and their combat development agencies are pressured by the materiel laboratories to utilize the latest and best technological product of each laboratory's latest initiative.

At the laboratory or materiel developer command level, technical staffs tend to support favorite concepts and technical advancements. It would be reasonable to expect a laboratory specialist in EMI (or any other speciality) to write a detailed specification that "pushed" the state of the art in his or her speciality area. Not only is the notion of waivers for these "ilities" against their professional emphasis, they have probably just been through one or more recent developments where the testing community and the initial equipment users have criticized some new item for marginal or unsatisfactory characteristics in his or her speciality area.

A defensive response to increase the particular specification standard for corrosion, shock, RFI, etc., is intuitive and detrimental to the concept of NDI. At this level, cost focus is largely on the next year's budget and these personnel are not involved in the budget allocation pressures of senior management. How could it be expected that a GS-11 corrosion expert at a government laboratory would consider that the cost of a corrosion specification he has written could influence acquisition in general? Each of these specification items, taken one at a time, can be shown to be important to a satisfactory product at relatively trivial cost. However, these items cascade by the "thousands" and get more stringent with each product generation.

Revision of NDI Acquisition Process

NDI Army Science Board

- *The present acquisition process and regulatory structure contains "disincentives" for NDI.*
- *There are examples of C^3I programs which have acquired NDI systems outside of the development acquisition process.*
- *The focus of NDI acquisitions is usually implemented only in the procurement phase of the acquisition cycle, thus trade-offs cannot be adequately addressed during the requirements generation (definition) phase.*

Section IV - Findings

Over the years, the many periodic efforts to halt or reverse this escalating trend toward more stringent specifications have, at best, only slowed the rate of growth.

This problem is pervasive and can be addressed most effectively by managers at the commodity commands and commanders at the combat development centers. These lower level officials can respond to guidance from more senior officials (Pentagon level), but micromanagement at that level (reviewing RFPs, for example) has usually been sincerely intentioned but largely ineffectual.

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Section IV - Findings

4. NDI Testing Procedures

The 1981 report of the ASB Ad Hoc Subgroup on Testing of Electronic Systems pointed out that the customary Army testing procedures and organization were partially responsible for the excessive time often needed to develop and deploy Army systems. One of the main advantages of NDI acquisition will be forfeited if such procedures are inflexibly applied to NDI purchases. It was discovered that AR 71-3, dated 8 March 1977, provides for the adequate level of NDI testing; however, most applications of an NDI solution to a requirement did not fully use this regulation.

One way to shorten the test schedule for NDI equipment, without undue risk, is for the Army to make greater use of vendor test data. Such data, often gathered to aid commercial marketing of the equipment, will usually reflect user experience with the equipment and will indicate the performance that the vendor can and will warrant.

The Army test community is particularly needed to test NDI equipment against environmental hazards peculiar to military use. Even here, however, flexibility is desirable. The ultimate users may wish to tolerate minor equipment deficiencies in the interest of obtaining up-to-date NDI equipment quickly and cheaply. The testing organization and procedures must allow times and places for such trade-offs to be negotiated between testers and other concerned parties, such as users and developers.

Military equipment can undergo environmental stress not only during use but also during transportation, handling and storage. Typical hazards include severe temperatures, sharp temperature changes, vibration, low pressure, high humidity and corrosive atmospheres. Electronic equipment is particularly vulnerable to high humidity. In many areas of the world C^3I equipment, originally designed for use in a civilian environment protected against high humidity, is likely to need special packaging or other protection to survive military storage, not to mention military use.

NDI Testing Procedures

NDI Army Science Board

- *Much of the timeliness of using NDI is lost in the complicated testing required by the Army.*
- *Although vendor test results are often limited in scope, they are almost always inadequately used.*
- *The "users" have shown, following field demonstrations, that they are often willing to accommodate minor deficiencies in NDI equipment that the Army technical community will not accept.*

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Review of TRI-TAC as Role Model

- *The subject system was in a period of contracting-sensitive negotiations and the panel did not believe that it should be reviewed at this time.*
- *Using the NDI Risk Classification Cube, developed by the panel, the revision of the TRI-TAC architecture was felt to be at the upper limit of risk in NDI classes.*

6. Life Cycle Support

ILS programs used in conjunction with formal development programs do not provide training, maintenance and spares in time to support most NDI hardware, software or systems.

These shortcomings result from the long planning and implementation cycles and are not easily overcome in a massive institution such as the U.S. Army.

Since the shortcomings are largely procedural, the modifications needed to support NDI must be largely procedural as well.

Life Cycle Support

- *Warranties are not a substitute for procedures and specifications that assure reliability.*
- *Normal repair and maintenance of NDI equipment may not satisfy wartime requirements.*
- *Integrated Logistics Support (ILS) documentation/ implementation support is expected to lag equipment delivery.*
- *The ILS package is the pacing item.*

Section IV - Findings

7. Impediments to NDI Initiatives

It was found that the entire acquisition structure has many cultural and procedural impediments to the acquisition of NDI. Many of these are real. Based on legitimate, well founded concerns, others are perceived problems which have cultural foundations. Whether real, perceived or both, these impediments have foundations deeply imbedded in the process. For example, users are reluctant to accept equipment less reliable, less temperature tolerant, less rugged, with less "soldier-proof" engineering than they have long fought to achieve. At another extreme, why should a GS-12 in a service laboratory compromise some corrosion or RFI specification he has fought to get adopted and is dedicated to preserving? Between those extremes, there are a myriad of other impediments at virtually every level. Since many of these concerns are legitimate and have solid foundations, finding a middle ground will be a challenging task.

There exists a complex mechanism and many heel-to-toe steps required in fielding a new equipment item. Many of these steps involve substantial time and may not be avoidable by NDI procurements. Often the actual engineering development is not the most time consuming part of the process. There are many examples where the ROC approval process has taken more than five years, as Dr. Trainor reported in his latest study. It is not likely that the special imperatives of NDI will simplify or shorten this task. Test, ILS and training communities all have special problems with NDI and many of these will be difficult to overcome.

Although there were many examples where successful NDI acquisitions by the Army were such a small part of the supplier's output that he would not provide detailed data, no examples were found where this had been a problem. There are some examples where the Army's potential leverage is diluted by restrictions on multiyear procurements. If the total buy could be firmly negotiated up front, the Army's leverage would be increased. Perhaps a complete buy-out in one year for selected items could give this leverage without the need for legislation relaxing the multiyear restriction.

Impediments to NDI Initiatives

NDI Army Science Board

- *Since there is a perception that NDI will not provide satisfactory materiel, little consideration is given to NDI approaches during the requirements generation process.*
- *Both real and perceived problems to operating commercial equipment in a military environment exist.*
- *Many of the procedural steps prescribed for the acquisition process that result in long delays in fielding new technology are not avoided by procuring NDI.*
- *For many potential NDI items the Army is not a large enough customer to influence design, obtain data packages, etc.*
- *Limitations on multiyear procurements restrict the Army's leverage for NDI acquisitions.*

8. Foreign Technology Items

Countries which have indigenous R & D and production capability have developed hardware, software and systems which are capable of meeting many U.S. Army functional requirements.

Interoperability with associated U.S. systems is the most important screening parameter for foreign NDI suitability.

Logistics provisions for wartime support constitute the next most important screening parameter for foreign NDI suitability.

Political and economic factors will favor use of U.S. developed alternatives unless there is a clear technical or time advantage for the foreign NDI hardware, software or systems.

The Rationalization, Standardization and Interoperability (RSI) process was established some years ago and is considered adequate for the procurement of much foreign NDI.

Foreign Technology Items

- Foreign NDI is available.
- Interoperability and wartime logistics provisions must be accommodated.
- Political factors complicate the acquisition of foreign NDI.
- There is an established mechanism for acquiring goods from foreign sources which the government already directs.

9. Software Issues

Software NDI is a system design issue. The utilization of software NDI must depend on system design considerations. In other words, NDI packages should be designed into the system early in the system design process; an overall architecture must be established that permits NDI packages to be embedded, disbursed and functionally distributed throughout the system. All engineering design processes identify first conceptually, then functionally, how elements of a system will be realized. The first place to emphasize an NDI strategy is during the preliminary design process by the establishment of NDI budgets. Subsequent design reviews should monitor adherence to these NDI goals.

Like hardware, software is a product of an engineering process. There are design procedures, guidelines and tools that should be utilized in the development of software just as there are for hardware projects. The design can, and should, be constrained and directed to assure that system software requirements can be partitioned into modularized and procurable NDI packages. Of course, it may turn out that one or more modules must be custom designed in order to accrue maximum NDI benefits.

The progress of the Ada Language System as a software engineering development system, and the success of Ada packages in the industry, supports the observation that software developed in the Ada environment is most likely to be designed like a good hardware product.

Software Issues

NDI Army Science Board

- *Software NDI is a system design issue.*
- *Software, like hardware, is a product of an engineering process.*
- *Software can be modularized and procured as NDI packages.*
- *Software developed in an Ada environment is most likely to be designed like a good hardware product.*
- *Hardware components can replace software modules.*
- *Software modules can address hardware deficiencies.*

There are two remaining points to consider. The first is that functions that in the past have customarily been software functions are being implemented with special purpose hardware. In many areas such hardware solutions (e.g., floating point multiply and divide, fast Fourier transforms) significantly simplify the remaining software system, which in turn may facilitate NDI package utilization.

The second point is that many hardware environmental problems such as noise, intermittent power and RAM errors have caused severe problems to software systems. For example, an ASB study on testing, 1981, highlighted such problems on systems with embedded computers. Those circumstances should be seriously considered as a design issue since real time software modules could address those types of hardware deficiencies.

Section V

Recommendations

Page

1. Generic 5-0
2. Market Surveys 5-3
3. NDI Testing 5-4
4. Logistics Issues 5-6
5. Software 5-8
6. Revised Acquisition Process 5-10
   a. Requirements Generation Phase 5-10
   b. Qualification Phase 5-13
   c. Bidding Phase 5-13

V

RECOMMENDATIONS

1. Generic

The Risk Classification Cube, which combines the three-cubed dimensions of developmental source, required modification and time to equip FUEs, can be used to evaluate the potential risk to the Army in choosing a NDI approach. Using the risk classification cube, the level of risk would be lowest for items that exist as commercial items, require no modification, and have a FUE of 15 months. The risk increases as the development source deviates from commercial items, both environmental and functional modifications are required and FUE extends to 40 months. The Army should consider its acquisition programs in terms of this classification scheme and should set policies and procedures regarding the level of potential risk that can be tolerated in NDI. The Army should also consider threshold levels of NDI risk and determine appropriate weightings of each dimension of the Risk Classification Cube during risk assessment.

Generic Finding

NDI Army Science Board

The Army should use the NDI Risk Classification Cube in describing policies and procedures.

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Market surveys to ascertain NDI availability must be more comprehensive

- *Market surveys to establish NDI technology availability should be performed by the material acquisition manager and not by a contractor who has a vested interest in a make-or-buy decision.*
- *Such market surveys should not be limited to only "paper responses."*

3. NDI Testing

NDI equipment that has performed successfully for the competitive commercial market has been "tested" to a considerable extent. Test data and user information obtained from vendors or otherwise ferreted out by Army procurement staff will certainly be more timely and often as useful as Army tests of the same equipment features. In any case, time and expense can usually be saved by directing Army testing primarily to those characteristics of the equipment which were not "tested" by the commercial marketplace, but which are important for military applications.

The 1981 ASB report on the Testing of Electronic Systems does not directly address the testing of NDI equipment, but many of the findings and recommedations in that report are pertinent to NDI acquisition. The report particularly emphasizes the support role of testing in securing Army systems which are better designed and specified, easier to operate and maintain, quicker to develop and field and cheaper to procure and sustain. Too easily, according to the report, testing procedures can hinder more than aid the achievement of these objectives.

The 1981 ASB report strongly advocated the practice of tailoring specifications to the specific system. The report stated: "Untailored system specifications, based on 'boilerplate' military standards, more often than not, result in equipment which does not meet the needs of the Army. Without a tailored specification, critical performance deficiencies will, despite a rigorous test program, remain largely undetected until the equipment enters the field." Conversely, much time, money and labor can be wasted satisfying irrelevant specifications if the specifications are not properly tailored.

Happily, the revised Military Standard on Environmental Test Methods and Engineering Guidelines, MIL-STD-810D, dated 19 July 1983, has adopted the tailoring concept. Such tailoring should ensure that NDI equipment is not subjected to unrealistic demands with respect to environmental tests. In addition, it should ensure that the equipment is protected throughout its life cycle against hazards encountered in both operational and nonoperational environments.

NDI testing must occur

- *More reliance should be placed on existing test data and user experience in appropriate applications rather than Army formal testing of NDI.*
- *The Army should review the ASB recommendations in their 1981 Study on Testing.*
- *Additional testing for NDI equipment will be tailored, including testing for nonoperational environments.*

4. Logistics Issues

Plan to tailor ILS programs for NDI to provide early support on a nonstandard basis.

Use contractor support in early years in conjunction with warranties.

Phase in Army training, maintenance and spares support on a normal cycle.

Use contractor repair and return depot level support for the long run where it is efficient and cost effective.

Use escrow technique to protect government interest in design and software rights should a contractor go out of business.

Logistics issues must be defined for NDI acquisitions

NDI Army Science Board

They must:

- *Satisfy the NDI equipment ILS requirements by using the vendor support system as the "base."*
- *Maintain the rotational base of required military functional users by expanding the training with industry program.*
- *Negotiate warranties that are tailored to the Army requirements.*

5. Software

The thrust of the recommendations is based upon findings of previous Army Science Board Studies (ASB on Testing - 1981, ASB on Software Acquisition - 1983 and ASB on Robotics and A/I - 1984) and numerous Army and DoD directives to standardize on the Ada Language System as a programming and development environment. Thus, Ada-oriented reusable software should be the dominant notion that underlies software NDI notions.

Recognizing that any progress in NDI starts with the system design process, the CDR recommendation follows. Clearly, the proliferation of reusable software will transfer the maintenance (ILS) environment to be more similar to the P/C-based commercial sector. In this environment, a modern commercial-like integrated logistics system for NDI software must be developed.

The point must be emphasized that no magic potion has existed for the commercial sector except the high return on investment of reusable software. Clearly the software embedded in the tactical world, whether it be oriented toward applications, run time support development, analysis or evaluation, can and should be packaged into reusable items.

Software

NDI Army Science Board

- ***Design systems so that NDI software is the item of choice.***
- ***Build an inventory of reusable Ada packages based upon extant commercial and tactical systems.***
- ***Utilize the Critical Design Review (CDR) process to encourage the proliferation of items from the inventory of reusable Ada packages as NDI items.***
- ***Develop an NDI software ILS system based upon 1985 "era," personal computer based, commercial practices.***

6. Revised Acquisition Process

a. Requirements Generation Phase

NDI must be considered during the requirements generation phase. During this phase, specifications are still fluid and a process of iteration can be utilized to achieve a cost and time effective approach. The appropriate material managers with their up-to-date data bases and contacts with industry and other NDI sources must be involved in optimizing requirements. Incentives must exist at all levels in the acquisition cycle.

Disincentives that must be overcome are as follows:

- The user usually must compromise some of his desires.
- The R & D community would have fewer requirements and presumably a smaller budget.
- The testing community would have a smaller budget if greater reliance were placed on existing NDI test data and user experience.

Incentives to use NDI are:

- User receives equipment at a much earlier date.
- From a global viewpoint, equipment and ILS costs are reduced.

The current acquisition process must be revised regarding NDI acquisitions

NDI Army Science Board

- *The incentive to use NDI must exist and needs to be managed at all levels, starting with requirements and continuing through acquisition and deployment.*
- *NDI applications should be considered during the requirements generation phase, when trade-offs are best applied.*
- *The appropriate material manager must identify the NDI candidate that most closely satisfies the functional requirements.*
- *NDI procurement methods for a particular application should shift risks on that procurement to the NDI source(s) and should provide incentives to ensure the shift of such risks.*

Section V - Recommendations

To overcome disincentives:

-Direction to use NDI must come from the "top-down" in the Army.

-Individuals involved in the acquisition process should be given appropriate recognition.

-The functional proponents for C^3I systems should be assigned clear responsibility for NDI advocacy and action.

The acquisition process should be modified to maximize the benefits of an NDI as follows:

-Training, maintenance and repair should make maximum use of existing supplier resources consistent with satisfying wartime conditions.

-The procurement process (after all specifications have been settled) should be segregated into two phases:

--Qualification Phase.

--Bidding Phase.

b. Qualification Phase

The length of time for the Qualification Phase is the sum of:

-Time required to make low risk modifications to an existing NDI.

-Time required to manufacture preproduction model(s) for Army evaluation.

-Time for Army evaluation.

The typical length of time for the Qualification Phase might be from three months for an off-the-shelf item to eighteen months for a complex system requiring low risk modifications to an existing NDI. Only those suppliers passing the Qualification Phase will be considered qualified for the Bidding Phase. In order to generate competition (i.e., two or more bidders), the Army must be prepared to guarantee procurement of a sufficient quantity to encourage suppliers to invest in the required modifications and to prepare priced proposals.

c. Bidding Phase

The Bidding Phase should be very short, since all qualified suppliers will have all their costs well prepared except for last minute changes required during evaluation phase.

One important comment is that Level 3 drawings should be required by the Army only after a specified quantity (covered by long-term options) have been acquired. One of the factors determining this specified quantity is the assurance that the Army will have two or more competing bidders.

If foreign technology is utilized, it must not degrade the national technical base. Licensing, second sourcing, or U.S. based ventures or joint ventures can be used to assure local availability of technology under changing international conditions.

DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY
WASHINGTON, DC 20310

22 February 1984

Dr. Wilson K. Talley
Chairman, Army Science Board
One Clipper Hill
Oakland, California 94618

Dear Dr. Talley:

Army C^3I research, development and acquisition traditionally has taken place in an environment which is user specific and is restricted to only a limited number of sources of supply. Commercial electronics systems acquisition, on the other hand, takes place in a highly competitive environment characterized by a much larger number of potential sources. It would seem that advantage should be taken, where possible, of this commercial marketplace to achieve efficiences of cost and schedule in the acquisition of Army C^3I systems. This should be done in a way that appropriately balances risks that could affect the battle. Recent Army acquisition decisions endorse this concept.

Accordingly, you are requested to appoint an Army Science Board panel of 8-12 members to review the way the Army develops requirements and specifies, develops, and acquires new C^3I systems. Considering the acquisition process we use today, what must be done to increase the use of commercial or "nondevelopmental" items (NDI), where appropriate, as viable substitutes for items developed under the "traditional" R&D process? In this context NDI includes equipment where someone else has paid for the R&D, such as military equipment in production for a foreign country. Specifically addressed should be:

(1) The technology available for converting NDI or commercial equipments for military applications. For example, benefits may be derived by employing resealable zip-lock plastic packaging or foam-lined aluminum cases to provide environmental protection rather than building these features into the item itself.

(2) Revisions where needed in the Army acquisition process to allow NDI and commercial solutions to be more easily employed.

(3) Review of the way we test systems being acquired to allow for appropriate testing of NDI equipment.

(4) Review of the recent revisions to our TRI-TAC architecture as an example of steps we are taking to encourage NDI.

(5) Logistics to support NDI.

(6) Problems that impede this initiative.

The panel should begin work this spring and prepare a draft final report by November 1984. I understand that Dr. Leon Riebman has agreed to chair the effort for the ASB. A list of proposed participants is attached.

MG Rockwell is the sponsor for this effort. BG Lee and MG Jolemore have agreed to serve as Senior Staff Advisors. LTC Frank Sisti is the DA Staff Assistant. Dr. Mark Epstein, Deputy for C^3 and Intelligence Systems, will serve as the Cognizant Deputy from our office.

Amoretta M Hoeber

Amoretta M. Hoeber
Principal Deputy Assistant Secretary of the Army
(Research, Development and Acquisition)

Attachment

APPENDIX B

GLOSSARY

Glossary

Ada	-	Ada Programing Language named in honor of Lady Ada Lovelace, First Programmer
ADEA	-	Army Development Employment Agency
AI	-	Artificial Intelligence
AIRMICS	-	Army Institute for Research and Management
AJ	-	Anti-jam
AR	-	Army Regulation
AS	-	Acquisition Strategy
ASB	-	Army Science Board
ATACS	-	Army Tactical Automated Communication System
AVRADA	-	Aviation Research and Development Agency
BOIP/QQPRI	-	Basis of Issue Plan/Qualitative and Quantitative Personnel Requirements Information
C^3I	-	Command Control Communications and Intelligence
CDR	-	Critical Design Review
CECOM	-	Communications, Electronics Command
CSA	-	Combat Support Agency
DARCOM (AMC)	-	Army Material Command
EMI	-	Electromagnetic Interference
EMP	-	Electromagnetic Pulse
ERADCOM	-	Electronic Research and Development Command
FMILS	-	Field Maintenance Integrated Logistics Systems
FUE	-	First Unit Equipped
ID	-	Infantry Division
ILS	-	Integrated Logistics Support
ILSP/AS	-	Integrated Logistics Support Plan/Acquisition Strategy

IRAD	-	Industrial Risk and Development
LPI	-	Low Probability of Intercept
LR/ROC	-	Letter Requirements/Required Operational Capability
LRU	-	Lowest Replaceable Unit
MFP	-	Material Fielding Plan
MILSPECS	-	Military Specifications
NDI	-	Nondevelopmental Items
O&O Plan	-	Operational and Organizational Plan
OASA IL&FM	-	Office of Assistant Secretary of Army for Installation, Logistics and Financial Management
ODCSRDA	-	Office of the Deputy Chief of Staff for Research Development and Acquisition
OPTADS	-	Office Project Manager Tactical Automated Data Systems
PA&T	-	Product Assurance and Test
P/C	-	Personal Computer
PM	-	Program/Project Manager
R&D	-	Research and Development
RAM	-	Random Access Memories
RFI	-	Radio Frequency Interference
RFP	-	Request For Proposal
RSI	-	Rationalization, Standardization and Interoperability (NATO)
SATCOM	-	Satellite Communications
SPADS	-	Staff Planning and Decision System
TACMIS	-	Tactical Management Information Systems
TAG	-	The Adjutant General

TM	-	Training Manual
TMDE	-	Test, Measurement, Diagnostic Equipment
TOE/MTOE	-	Table of Organizational Equipment/Modified
TRADOC	-	Training and Doctrine Command
TRI-TAC	-	Tri-Services Tactical Automation Communication

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APPENDIX C

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